UNIVERSITI TEKNOLOGI MALAYSIA

DECLARATION OF THESIS / UNDERGRADUATE PROJECT REPORT AND COPYRIGHT

Author's full name : NURLIA SYAKILA BINTI CHE HUSIN

Date of Birth : 29th JULY 1990

Title : DIGITAL CHESS CLOCK USING PIC 16F877A MICROCONTROLLER

Academic Session : 2012/2013

I declare that this thesis is classified as:

☐	**CONFIDENTIAL**	(Contains confidential information under the Official Secret Act 1972)*
☐	**RESTRICTED**	(Contains restricted information as specified by the organization where research was done)*
☑	**OPEN ACCESS**	I agree that my thesis to be published as online open access (full text)

I acknowledged that Universiti Teknologi Malaysia reserves the right as follows:

1. The thesis is the property of Universiti Teknologi Malaysia
2. The Library of Universiti Teknologi Malaysia has the right to make copies for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

SIGNATURE	**SIGNATURE OF SUPERVISOR**
900729-03-6168	DR NASRUL HUMAIMI BIN MAHMOOD
(NEW IC NO/PASSPORT)	**NAME OF SUPERVISOR**
Date: 24th JUNE 2013	Date: 24th JUNE 2013

NOTES: * If the thesis is CONFIDENTAL or RESTRICTED, please attach with the letter from the organization with period and reasons for confidentiality or restriction.

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Engineering (Electrical- Electronics)"

Signature	:	…….....
Name of Supervisor	:	Dr. Nasrul Humaimi bin Mahmood
Date	:	24th June 2013

DIGITAL CHESS CLOCK USING PIC 16F877A MICROCONTROLLER

NURLIA SYAKILA BINTI CHE HUSIN

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Bachelor of Engineering (Electrical-Electronics)

Faculty of Electrical Engineering
Universiti Teknologi Malaysia

JUNE 2013

I declare that this thesis entitle "*Digital Chess Clock using PIC 16F877A Microcontroller*" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature: ……

Name of: NURLIA SYAKILA BINTI CHE HUSIN

Date: 24th JUNE 2013

Dedicated, in thankful appreciation
for support, encouragement and understanding
to my beloved family members and friends.

ACKNOWLEDGEMENT

Alhamdulillah, thanks to Allah S.W.T. for His blessing and mercy, for giving me strength to complete the final year project. Without His guidance surely this project cannot be finish. In this given opportunity to express my deepest appreciation, I would like to give my deepest grateful for those who help without wish for the return except the knowledge will be continuous forever. First of all, I would like to extend my utmost gratitude to my one and only supervisor, Dr. Nasrul Humaimi bin Mahmood for his continuous guidance, support and invaluable advices to ensure that I will be able to finish this project. The supervision and support he gave me has truly helped me in progression and smoothness of this project and his cooperation is much appreciated. Not to forgotten that I would like to give my appreciation to all my family members for their support in my finance and understanding throughout the accomplishment of my final year project. Special thanks also for all my beloved friends who help me direct or indirectly in my project. Your help is much appreciated. Lastly, I would like to give my special gratitude to University of Technology Malaysia (UTM) and all the staff for providing the equipment and guidance throughout the completion process.

ABSTRACT

The purpose of this study is to design the alternative way of displaying digital chess clock by using PIC 16F877A microcontroller. Two methods involve in design the digital chess clock which is hardware design and software design. The PIC 16F877A microcontroller along with PIC start-up kit SK40C has been proposed in this study to design the digital chess clock using the microcontroller. The result of the simulation has been shown using LCD display and an additional buzzer has been used as an alarm system in the digital chess clock. The MPLAB IDE and PICkit2 software has been used in this project to write the source code and to generate the hex file into microcontroller. The IUC00B PIC programmer has been used in this project as an intermediate element to connect the hardware design and software design. The result has shown the time limit for the player to finish the game and the winner of the game if the other player cannot complete the move in the time given.

ABSTRAK

Projek ini dilakukan bertujuan untuk mereka bentuk jalan lain untuk memaparkan jam catur digital menggunakan mikropengawal PIC 16F877A. Dua kaedah terlibat dalam mereka bentuk jam catur digital ini iaitu menggunakan mereka bentuk perkakasan elektronik dan mereka bentuk perisian. Mikropengawal PIC16F877A bersama dengan kit permulaan mikropengawal SK40C telah digunakan dalam projek ini untuk mencipta jam catur digital ini. Keputusan projek ini di tunjukkan melalui paparan LCD dan alatan tambahan dalam projek ini iaitu 'buzzer' telah digunakan sebagai sistem penggera untuk jam catur digital. Untuk mereka bentuk perisian bagi projek ini, perisian MPLAB IDE dan PICkit 2 telah digunakan untuk menulis kod dan menjana fail hex ke dalam mikropengawal. 'Programmer PIC' telah digunakan sebagai komponen perantaraan untuk menghubungkan perkakasan elektronik dan reka bentuk perisian. Keputusan projek ini untuk melihat had masa untuk kedua-dua pemain dan pemenang untuk permainan ini jika salah seorang pemain tidak dapat menyelesaikan gerakan catur dalam masa yang ditetapkan.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENTS	vii
	LIST OF TABLES	x
	LIST OF FIGURE	xi
	LIST OF ABBREVIATIONS	xiii
1	**INTRODUCTION**	1
	1.1 Background	1
	1.2 Problem statements	2
	1.3 Objectives	2
	1.4 Scope	2
	1.5 Thesis Outline	3

2	**LITERATURE REVIEW**		5
	2.1	Related Research	5
	2.2	Background of Chess Clock	6
		2.2.1 Analog Clock	6
		2.2.2 Digital Clock	7
		2.2.3 History of Chess Clock	7
		2.2.3.1 Sandglass Clock	8
		2.2.3.2 Mechanical Timing Device	9
	2.3	Peripheral Interface Controller (PIC)	10
		2.3.1 PIC 16F877A Microcontroller	10
		2.3.2 SK40C PIC Startup Kit	13
		2.3.3 IUC00B PIC Programmer	14
	2.4	LCD Display	15
	2.5	Software Implementation	16
		2.5.1 MPLAB IDE Software	16
		2.5.2 PICkit 2 Software	17
3	**METHODOLOGY**		19
	3.1	Hardware Implementation	19
		3.1.1 PIC 16F877A Connected to SK40C Startup Kit and LCD Display	21
		3.1.2 Buzzer Connection with Microcontroller	23
	3.2	Software Design	24
		3.2.1 Algorithm and Programming in MPLAB IDE Software	24
		3.2.1.1 Initialization of configuration for PIC 16F877A Microcontroller	27
		3.2.1.2 Initialization of Ports	27
		3.2.1.3 Initialization of LCD	27
		3.2.1.4 Initialization of Buzzer	28

3.2.1.5 Push Switch Button 28
3.2.1.6 Interrupt Explanation 28
3.2.2 MPLAB IDE and PICkit 2 Software Setup 29
3.2.2.1 MPLAB IDE Software Setup 29
3.2.2.2 PICkit 2 Software Setup 32

4 RESULT AND DISCUSSION 34

4.1 Result and Discussion 34

5 CONCLUSION 41

5.1 Conclusion 41
5.2 Problem 42
5.3 Recommendation 43

REFERENCES 44
APPENDICES 46

LIST OF TABLES

TABLE NO.	TITLE	PAGE
2.1	First Two Player Who Used Time Limit	9
3.1	Pin Connection of PIC 16F877A with SK40C Startup Kit and LCD Display	22

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
2.1	Chess Clock with Pendulum	10
2.2	40 Pins of PIC 16F877A Microcontroller	11
2.3	Block Diagram of PIC16F877A Microcontroller	12
2.4	SK40C Startup Kit	13
2.5	IUC00B PIC Programmer	14
2.6	LCD Display Embedded to SK40C Startup Kit	15
2.7	MPLAB IDE Window for Source Code	17
2.8	Connected PICkit 2 Software with PIC Programmer	18
3.1	Block Diagram of Digital Chess clock using PIC 16F877A Microcontroller	20
3.2	Circuit Diagram of Digital Chess Clock	21
3.3	Buzzer Connection of Digital Chess clock	23
3.4	Flow Chart of PIC 16F877A Main Program	25
3.5	Flow Chart of Interrupt Function	26
3.6	MPLAB IDE Programming Setup	29
3.7	Source Code of the Project	30
3.8	Successfully Build Program at MPLAB IDE	31
3.9	Successfully Connection of IUC00B PIC Programmer	32
3.10	Successfully Generate Hex File into PIC Microcontroller	33
4.1	Two Player Start the Chess Game	35
4.2	Time Taken for Player1 Move the Chess	36

4.3	Time Taken for Player2 Move the Chess	37
4.4	LCD Display for which Player Win and Lose	38
4.5	Game Over for Both Player	39

LIST OF ABBREVIATIONS

DGT	Digital Game Technology
FPGA	Field Programmable Gate Array
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MPLAB IDE	MPLAB Integrated Development Environment
PIC	Peripheral Interface Controller
VHDL	VHSIC Hardware Description Language

CHAPTER 1

INTRODUCTION

1.1 Background

Chess is a game where two players play the game at the same. There was no time limit to play the game in earlier days. Since there is no time limit, the game can last for many hours. To make the game more interesting and suitable for the tournament, the chess clock was being design. The first clock is name as pendulum clock and finally analogue chess clock was being design. To make the life easier, the digital chess clock was being implemented. By designing this digital chess clock using PIC microcontroller, the problem can be solved since this project is using programmable microcontroller. To play the game, each player is given a finite time in completing the game. The rules of the game is simple which is if one of the player run out of time first, he will lose the game. The term for the time in chess game is chess clock. Nowadays, there was no longer need of analogue clock because of not accurate time during play the game.

1.2 Problem Statement

The existing digital clock is using the seven segment display that displays the time limit for the game. This project will focus on displaying the time limit by using the LCD display which is the other alternative than using seven segments. Other than that, the other digital chess clock has only one function which is to show the time limit of the game. This project will propose the other function of digital chess clock such as LED light indicator and buzzer.

1.3 Objectives

The objectives of this project are:

1. To design the digital chess clock using PIC 16F877A and implement onto board SK40C PIC start-up kit.
2. To interface LCD display to microcontroller.

1.4 Scope

In order to achieve the objectives of the project, there is several scopes need to be highlighted. The scopes of the project include the hardware and software parts. For the hardware part, chess clock circuit has been designed in order to display the time of

the game. The circuit consists of PIC 16F877A microcontroller, LCD display, buzzer and LED light. The time will be displayed in LCD display. Since the LCD display was much cheaper than to use 12 seven segment to display hour, minutes and seconds for both player. By using LCD display, we can display the time for both player simultaneously. Apart of using LCD display to show the time limit, buzzer will be used as an alarm to show that the player runs out of time and LED light will be used to show which player move at that time.

For the software part, MPLAB IDE was used to do the programming and to compile all source code used in the project. The software MPLAB IDE will then be connected to PICkit 2 to program the source code into the microcontroller.

1.5 Thesis Outline

This thesis contains five chapter altogether. Chapter one describes the objective and scope of this project as well as the problem statement of the project.

Chapter two will discuss more about the literature review and related researches regarding designation of digital chess clock using PIC 16F877A. It well discuss about the theory behind the electronics components used in the project.

In chapter three, the discussion will be on the methodology of the project and all the steps involved for the hardware and software design.

Chapter four will discuss about the result and discussion of the project. All photos about the project will be displayed in here. All result consists of hardware part and software part. Both parts will be shown here. The discussion about the result of the project will be discussed in detail here.

The last chapter of the thesis which is chapter five will conclude the project and some recommendations for further works will be discuss here as well as the problem involved during carrying out the project. All the problems will be list out here.

CHAPTER 2

LIRERATURE REVIEW

2.1 Related Research

Rosmira Roslan (2008) developed digital chess clock using the FPGA board. The research is using the ISE software and FPGA Xilinx board. The designation of the digital chess clock is using VHDL code. Chess clock are really two connected clocks. While the player 1 is thinking, his clock is running and the player 2 clock stop running. There is only one clock running at a time and each player has their own separate amount of time. In blitz chess, each player has a finite amount of time for the entire game which is only five minutes. If the time is up, the person who runs out of time will lose. This type of game will make chess more interesting and fun to play.

M. Zhafri (2010) developed a speed chess clock for his research. The improvement of the speed chess clock is from analog clock to digital clock and expensive chess clock to lower price of chess clock. His research investigates the used of programmable microcontroller and the implementation of the PIC microcontroller.

The Speed Chess Clock (SCC) is a programmable clock that indicates player's turn by LED. The buzzer is to indicate the time out is approaching and the double 'beep' for the time out. His research introduces the LCD display to display the time and other components as the output of the clock. The programmable microcontroller used in his research was PIC 16F877A.

2.2 Background of Chess Clock

2.2.1 Analog Clock

In 1870 there was game played for the first time with the use of timer. There was such a success that in 1883, it was recorded that the first tournament was played by using a real chess clock with a pendulum. A time limit of 15 moves was regulated by the connected stop clocks. When one clock was stopped, the other will start running and vice versa. It was designed by Thomas Bright Wilson (1843-1915) of Manchester with an advice from Blackburne. The first patent for a clock was issued in 1884 to Amandus Schiewater of Liverpool. The clock was used by Steinitz-Lasker match for the world championship in New York, 1894.

After five years in 1889, the flag was invented by Meijer, the secretary of the Dutch Chess Federation. It was easier to see when the times run out because the flag fell with time run out. In the early days of clocks, surpassing the time limit was not considered losing a game. In the seventies, electric clocks were invented but it was initially unsuccessful until Dutchmann Albert Vasse invented the DGT (digital game technology) digital clock which is commonly used.

2.2.2 Digital Clock

After the implementing of the chess clocks, the Jaques "chess timing clock" was introduced in the 1890s and sold for 21 shillings. In 1990, the analogue push-button was then perfected by Veenhoff of Groningen. The first electronic chess clock was the created by Bruce Cheney, a Cornell University Electrical Engineering student in 1973. The first patent was granted to Joe Meshi on a fully operational microprocessor based digital chess clock. Almost all chess tournaments today use digital clocks due to the different time controls with delay or time increments added to a clock. The analogue clock was not in use anymore because of inaccurate accuracy and many other problems.

2.2.3 History of Chess Clock

In the very early days, there were no time limit of how long will the chess game will be played. In 1834, several famous matches between Louis La Bourdonnais and Alexander McDonnell were recorded and at that time, time was not an issue. According to George Walker, three quarter of one entire game "was spent in dwelling and pondering and strategizing". Many of the games lasted long bur the exact duration of each move was not recorded. Walker who there when the game between La Bourdonnais and McDonnell once recorded the time for one move which is 55 minutes for one move and then said that " McDonnell was incomparably the slower player". On the other time in 1843, several impartial onlookers described that a match between Howard Staunton and Pierre St.Amant as a test of a physical endurance rather than chess match. It is reported that their 21st match game took 66 moves and 14 and half hour. These caused the prolongations and attempts to fatigue and to wear out the opponent and this showed that an average game lasted for nine hours.

Previously, chess was governed by an unwritten amateur privilege that allows players play chess match with an unlimited time for each move. It was being recorded that the Staunton-St.Amant average match game of 1843 games was nine hours and that as much as two hours and 20 minutes was spent by one player for one single move in London tournament. Because of the competitive chess game between the Bourdonnais and McDonnell, there were some questions of fairness whether a game should be played with an enormous amount of time. The rise of questions about the fairness of the game slowly turns to inventing of the game with a time limit.

2.2.3.1 Sandglass Clock

Firstly suggested a maximum time limit of the match was famed French player Alexandre deschapellas shortly after the Staunton matches. At the first-ever World Tournament held in London in 1851, there was a contributor named A. Cantab to write "Let each player have a three hour sandglass at his elbow and a friend on either side to turn it. While the player is thinking, the sand must be allowed to run. While his opponent is thinking, the sand must be laid horizontally on the table and the running suspended". This very first timing proposal was considered evaluating the entire cycle of moves and not just one move.

After that, German chess master Baron von der Lasa proposed that each game will be using two watches and the time was noted by each opponent. This proposal was much better than using sandglass because of the accuracy using sandglass. It was proven that problem such as temperature and humidity both affect the accuracy of the sandglass. This method was quietly popular in Europe since the sandglass method was proven to be problematic. In 1861, the game between Anderssen and von Kolisch was

the first match played with time limit by using sandglass. In London 1862, time controls were novelties for a big tournament which is 24 moves had to be played in two hours and time measured by sandglass.

Table 2.1 First Two Player Who Used Time Limit

No	FLAGS	NAME	01	02	03	04	05	06	07	08	09	TOTAL
01		**Karl Ernst Adolf Anderssen**	1	0	0	1	0	½	1	½	1	5.0/9
02		**Baron Ignaz von Kolisch**	0	1	1	0	1	½	0	½	0	4.0/9

2.2.3.2 Mechanical Timing Device

The first invented mechanical timing device was in 1883 to the delight of the entire chess community. This chess clock made its debut in London in 1883 as the invention of Thomas Bright Wilson of Manchester. It is similar to the states where two identical pendulum clocks set on opposite ends of a balance beam. When one player finished his move, he moved his clock into a position that stopped its pendulum and started the opponent's timer. The 'tumbling' clock was then manufactured by Fattorini & Sons of Bradford in England.

The first tournament by using mechanical device timing and the time usage during the games measured was when the tournament of London in 1851. The players used more than two hours for a move and a several solution was came up such that a time limit of five minutes for a move and fines for exceeding the time limit.

Figure 2.1 Chess Clock with Pendulum

2.3 Peripheral Interface Controller (PIC)

2.3.1 PIC 16F877A Microcontroller

PIC 16F877A microcontroller is a programmable microcontroller used to generate many function of the device. Since this is a programmable microcontroller and can generate many function, LED light indicator and buzzer is being defined [11]. Buzzer will be used as an alarm system and LED light as an indicator. The configuration of the microcontroller is easy compared to other microcontroller. So the microcontroller can help the setting of the digital chess clock easier since the microcontroller has many functions.

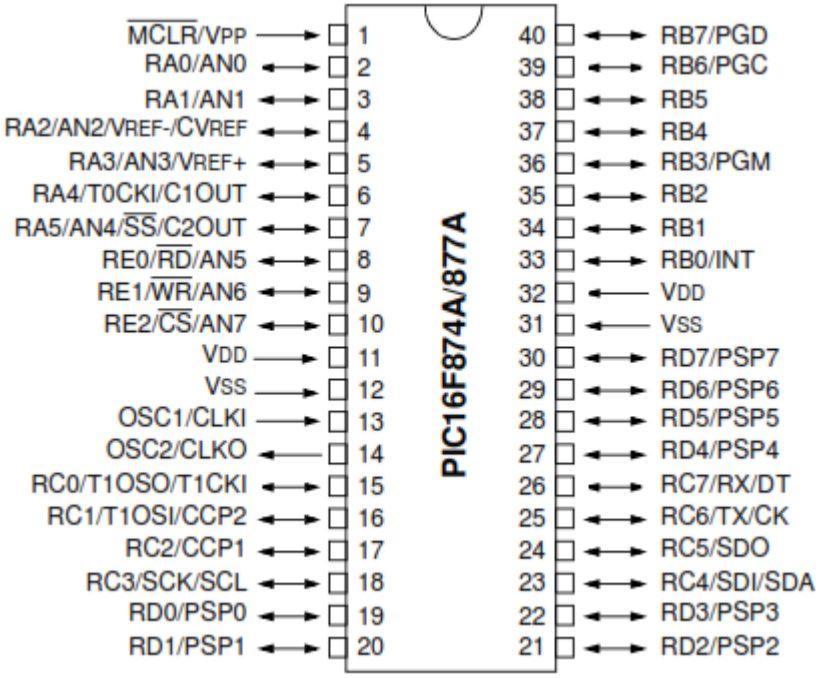
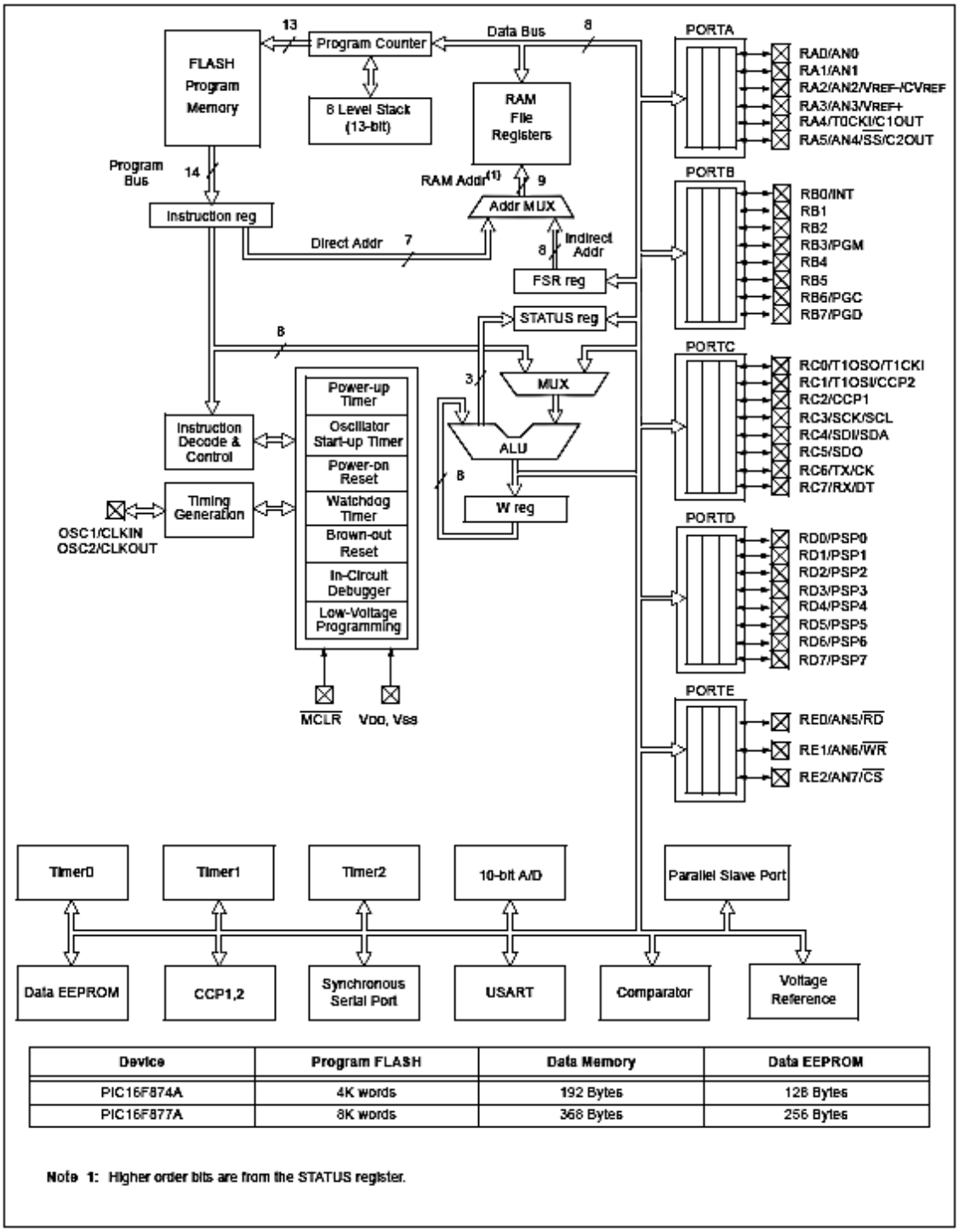


Figure 2.2 40 Pins of PIC 16F877A Microcontroller

Figure 2.2 show the 40 pins of PIC 16F877A microcontroller. This microcontroller has Port A to Port D and other pins. These 40 pins microcontroller has programmed flash 8K words, data memory 368 bytes and data EEPROM 256 bytes [12]. Each pin has the own function [12] to be used. Port B is used as output port and other port can be used as input or output port. The full block diagram of the PIC 16F877A will be shown on figure 2.3.



Device	Program FLASH	Data Memory	Data EEPROM
PIC16F874A	4K words	192 Bytes	128 Bytes
PIC16F877A	8K words	368 Bytes	256 Bytes

Note 1: Higher order bits are from the STATUS register.

Figure 2.3 PIC 16F877A Block Diagram

2.3.2 SK40C PIC Startup Kit

SK40C PICkit is a 40 pins PIC microcontroller start - up kit. This start-up kit comes with additional features such as [11]:

- 2 x programmable switch
- 2 x LED indicator
- Turn pin for crystal
- USB on board
- PICkit port

Figure 2.4 SK40C Start-up Kit

The advantage of using this start- up kit is that the LED and switch is already connected. With the existence of this PICkit, the life becomes easier. SK40C come with UIC00A/B ICSP USB programmer connector to import the hex file into the microcontroller.

2.3.3 IUC00B PIC Programmer

Figure 2.5 shows the IUC00B PIC programmer connected to SK40C PICkit and USB connected to computer [11]. This programmer function as the intermediate device to import the hex file generated in MPLAB IDE software into the microcontroller.

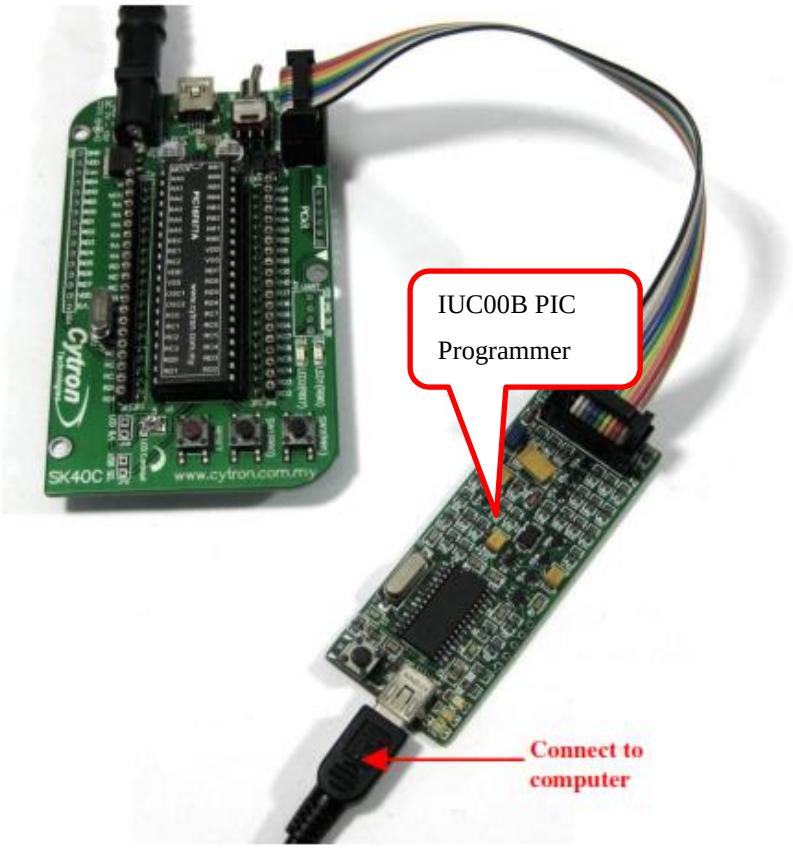


Figure 2.5 IUC00B PIC Programmer

2.4 LCD Display

The 2 x 16 character LCD display offer character display for an embedded system. This LCD display can be used to display numerical information, text and special symbol [11]. For this project, the LCD display is used to show the time limit of chess clock and the text of who win and lose the game. This concept of using the time limit in playing chess game was almost the same with Blitz chess [6]. Figure 2.4 shows the LCD display embedded to the SK40C start-up kit.

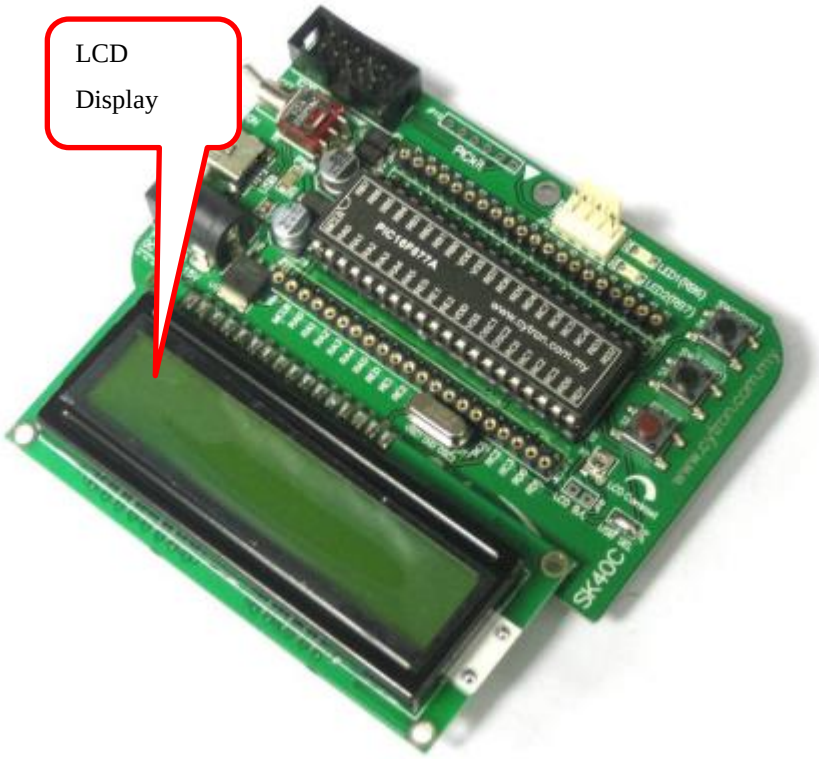


Figure 2.6 LCD Display Embedded to SK40C Start-up Kit

2.5 Software Implementation

2.5.1 MPLAB IDE Software

MPLAB IDE software is a Windows based Integrated Development Environment for the Microchip Technology Incorporated PIC microcontroller (MCU) and dsPIC digital signal controller (DSC) families [13]. In the MPLAB IDE, we can:

i. Create source code using the built in editor.
ii. Assemble, compile and link source code using various language tools. An assembler, linker and librarian come with MPLAB IDE. C compilers are available from Microchip and other third party vendors.
iii. Debug the executable logic by watching program flow in real time emulator such as MPLAB IDE.
iv. Make timing measurements
v. View variables in watch windows.

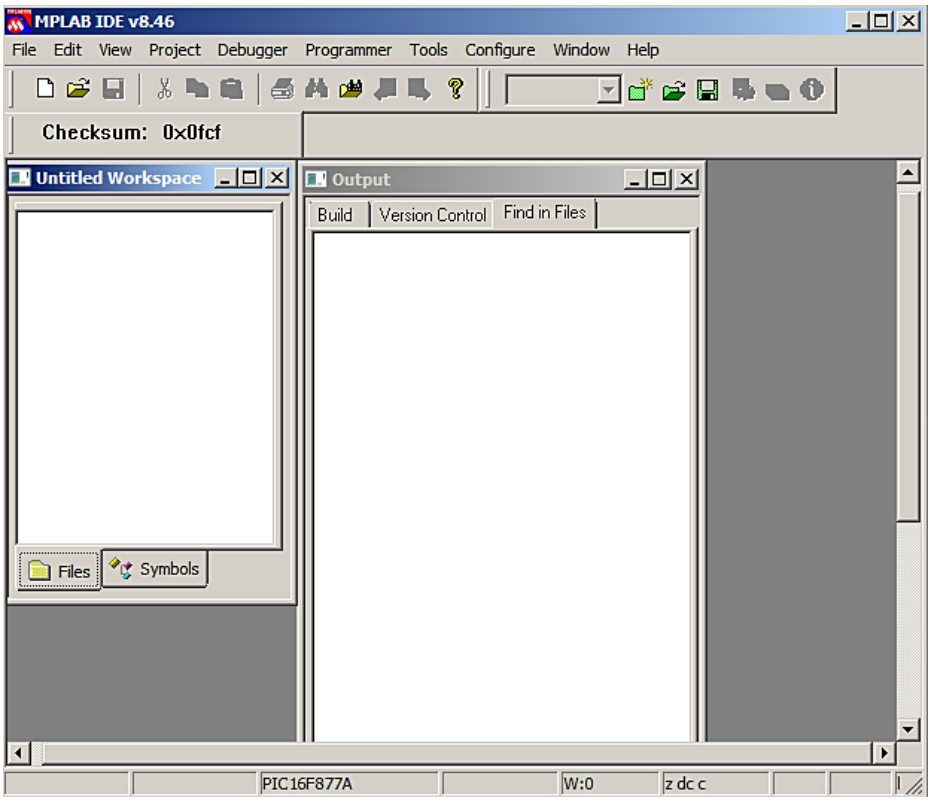


Figure 2.7 MPLAB IDE Window for Source Code

2.5.2 PICkit 2 Software

PICkit 2 software is used to generate hex file into the microcontroller. The hex file is gotten from the successfully build program with MPLAB IDE software. The connected UIC00B PIC programmer and SK40C start-up kit will then generate the hex file into microcontroller. The connected programmer will find the type of microcontroller used. Ensure the type of microcontroller find in the PICkit 2 software is same as the selected microcontroller in the MPLAB IDE software. This software used to import the hex file generated in the MPLAB IDE to the microcontroller. The correct hex file will then generate the output for the hardware design. The entire step to setup the PICkit 2 software will be discussed in detail in methodology part. Figure 2.8 shows

the connected PICkit 2 software with IUC00B PIC programmer. The 3FFF stated in the window shows the ready state of software to import the hex file and write into the microcontroller.

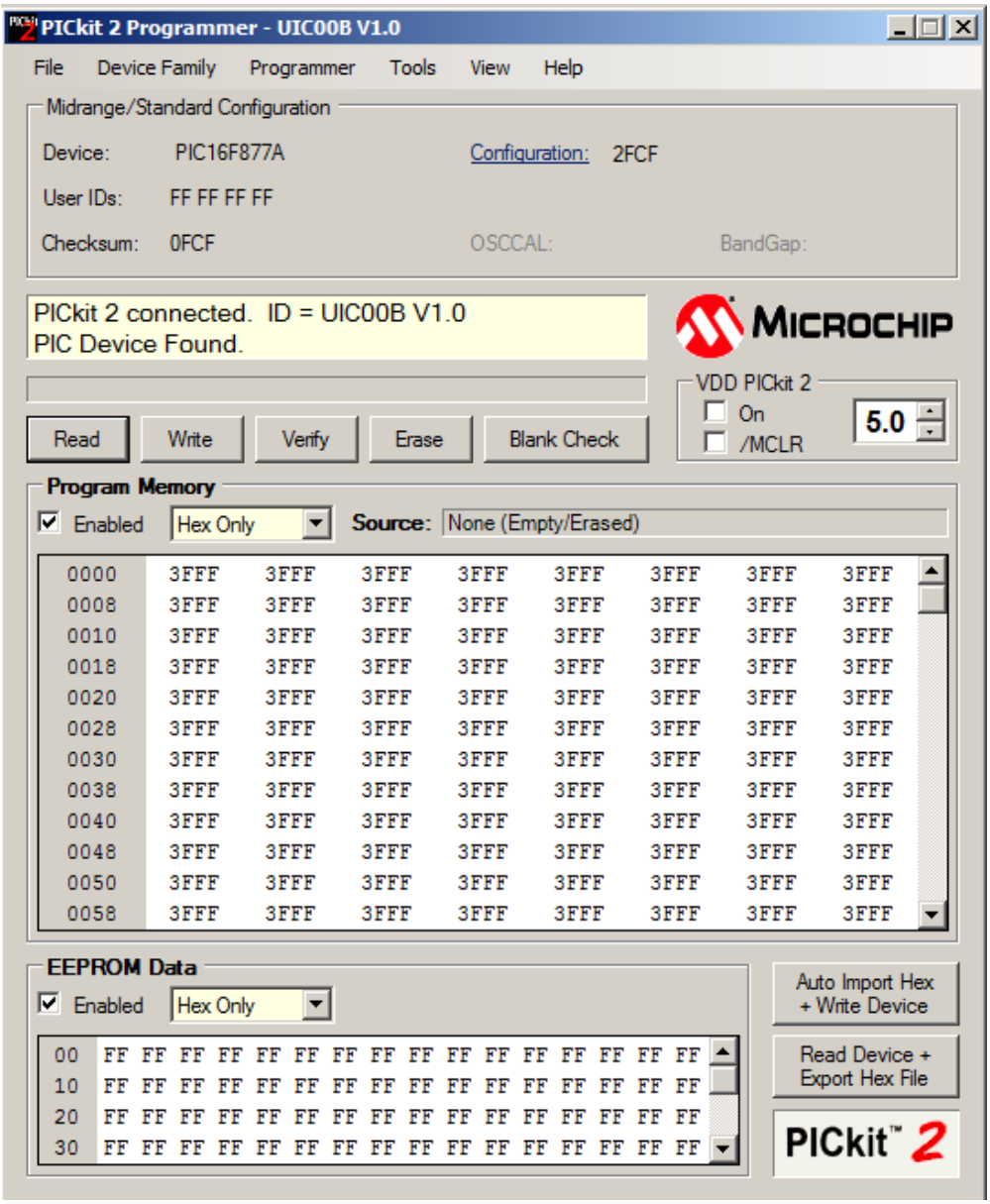

PICkit 2 Programmer - UIC00B V1.0
File
Device Family
Programmer
Tools
View
Help
Midrange/Standard Configuration
Device: PIC16F877A
Configuration: 2FCF
User IDs: FF FF FF FF
Checksum: 0FCF
OSCCAL:
BandGap:
PICkit 2 connected. ID = UIC00B V1.0
PIC Device Found.
MICROCHIP
VDD PICkit 2
On
/MCLR
5.0
Read
Write
Verify
Erase
Blank Check
Program Memory
Enabled
Hex Only
Source: None (Empty/Erased)
0000 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0008 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0010 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0018 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0020 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0028 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0030 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0038 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0040 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0048 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0050 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0058 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
EEPROM Data
Enabled
Hex Only
00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
10 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
20 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
30 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
Auto Import Hex + Write Device
Read Device + Export Hex File
PICkit™ 2

Figure 2.8 Connected PICkit 2 Software with PIC Programmer

CHAPTER 3

METHODOLOGY

3.1 Hardware Implementation

The hardware implementation of the project consists of PIC 16F877A microcontroller and LCD display connected to SK40C start-up kit. All components were being connected using bread board. Block diagram of the project is shown in figure 3.1.

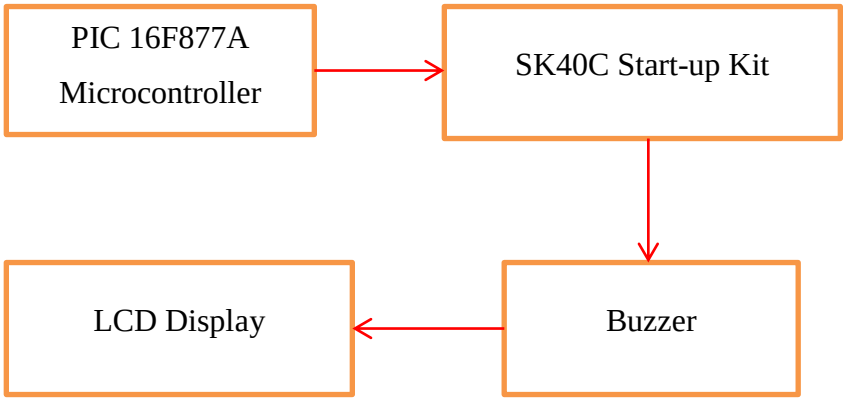


Figure 3.1 shows the block diagram of implementation of hardware design of digital chess clock. The PIC 16F877A microcontroller was connected to SK40C start-up kit and connected to buzzer through bread board. The SK40C PICkit is already have LED light embedded inside. The connected PIC 16F877A and SK40C start-up kit will then connect with LCD display. The LCD display used to display the time limit of the chess game and show the winner and loser of the game. After that, connect the hardware implementation to PIC programmer UIC00B to program the source code to PIC microcontroller. The PIC microcontroller will save the source code inside until new source is being replaced. Figure 3.2 shows the circuit diagram of the hardware implementation of the project.

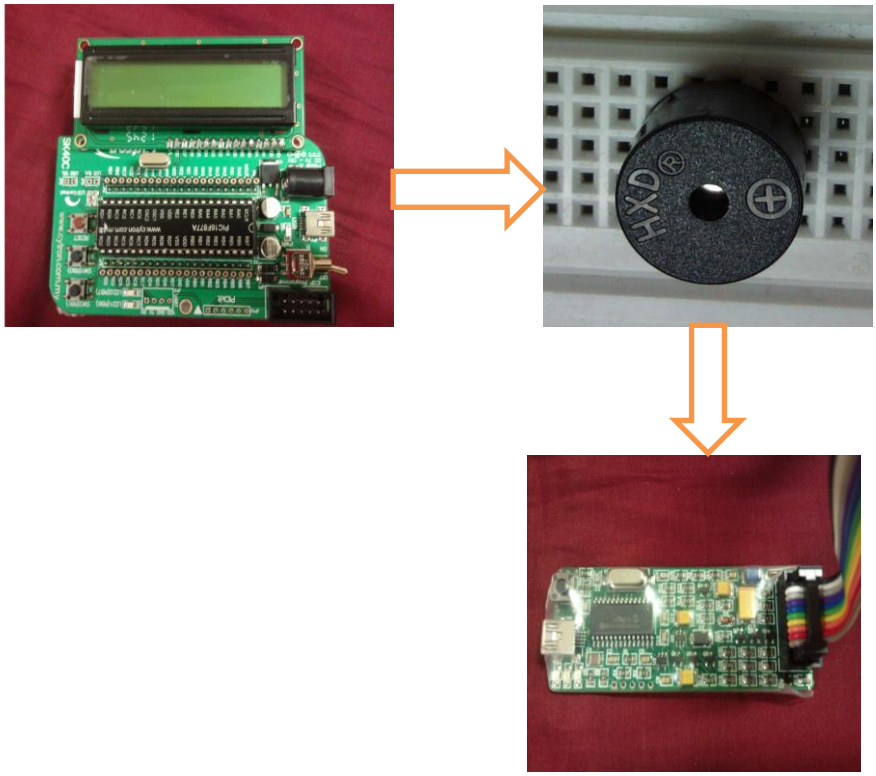


Figure 3.2 Circuit Diagram of the Hardware Implementation

3.1.1 PIC 16F877A Connected to SK40C Startup Kit and LCD Display

The connection of the LCD display to the SK40C startup kit is to display the time limit of the chess game. Table 3.1 shows the pins connection of PIC 16F877A to the LCD display. Pins that are not stated in the table are not used and left hanging. The microcontroller that connected with power supply will then receive the desired output

and display it at the LCD. The programmed microcontroller will operate until reset button is push.

Table 3.1 Pin Connection of PIC 16F877A with SK40 Startup Kit and LCD Display

Pin	Name	Pin Function	Connection
1	GND	Ground	GDN
2	VDD	Positive Supply for LCD	5V
3	CON	Brightness Adjust	Connected to Preset to Adjust Brightness
4	RB4	Select Register, Select Instruction or Data Register	Pin RS of LCD
5	GND	Ground	GND
6	RB5	Start Data Read or Write	Pin E of LCD
7	RD0	LCD Data Bus Pin	Pin D0 of LCD
8	RD1	LCD Data Bus Pin	Pin D1 of LCD
9	RD2	LCD Data Bus Pin	Pin D2 of LCD
10	RD3	LCD Data Bus Pin	Pin D3 of LCD
11	RD4	LCD Data Bus Pin	Pin D4 of LCD
12	RD5	LCD Data Bus Pin	Pin D5 of LCD
13	RD6	LCD Data Bus Pin	Pin D6 of LCD
14	RD7	LCD Data Bus Pin	Pin D7 of LCD
15	VDD	Backlight Positive Input	VDD
16	B/L	Backlight Negative Input	Connected to JP8
RA6	OSC2	Crystal	Turn Pin (JP7)
RA7	OSC1	Crystal	Turn Pin (JP7)
RB0	SW1	Digital Input	“SW1” Switch
RB1	SW2	Digital Imput	“SW2” Switch
RB2	Buzzer	Alarm Output	Pin 35 PIC 16F877A

3.1.2 Buzzer Connection with Microcontroller

Buzzer that acts as an alarm system in this digital chess clock will be connected at pin 35 on PIC 16F877A microcontroller and ground. This alarm system will sound as the time limit for the game runs out. The connection of the buzzer is given in figure 3.3.

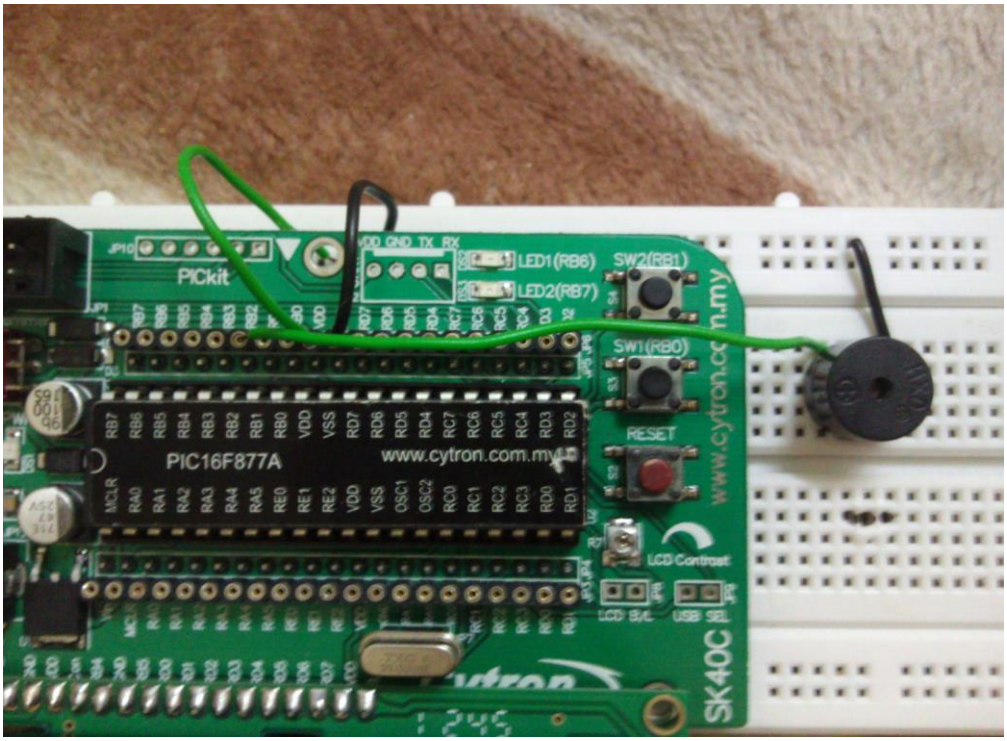


Figure 3.3 Buzzer Connection of Digital Chess Clock

3.2 Software Design

3.2.1 Algorithm and Programming in MPLAB IDE Software

An algorithm has been developed to make the microcontroller read the input and display the output accordingly. The algorithm has been established and been represented by a flowchart in figure 3.4 and figure 3.5. The flowchart is then translated into C language and compiled using MPLAB IDE, the PIC 16F877A microcontroller software development tool. The source code for the program can be referred in appendix.

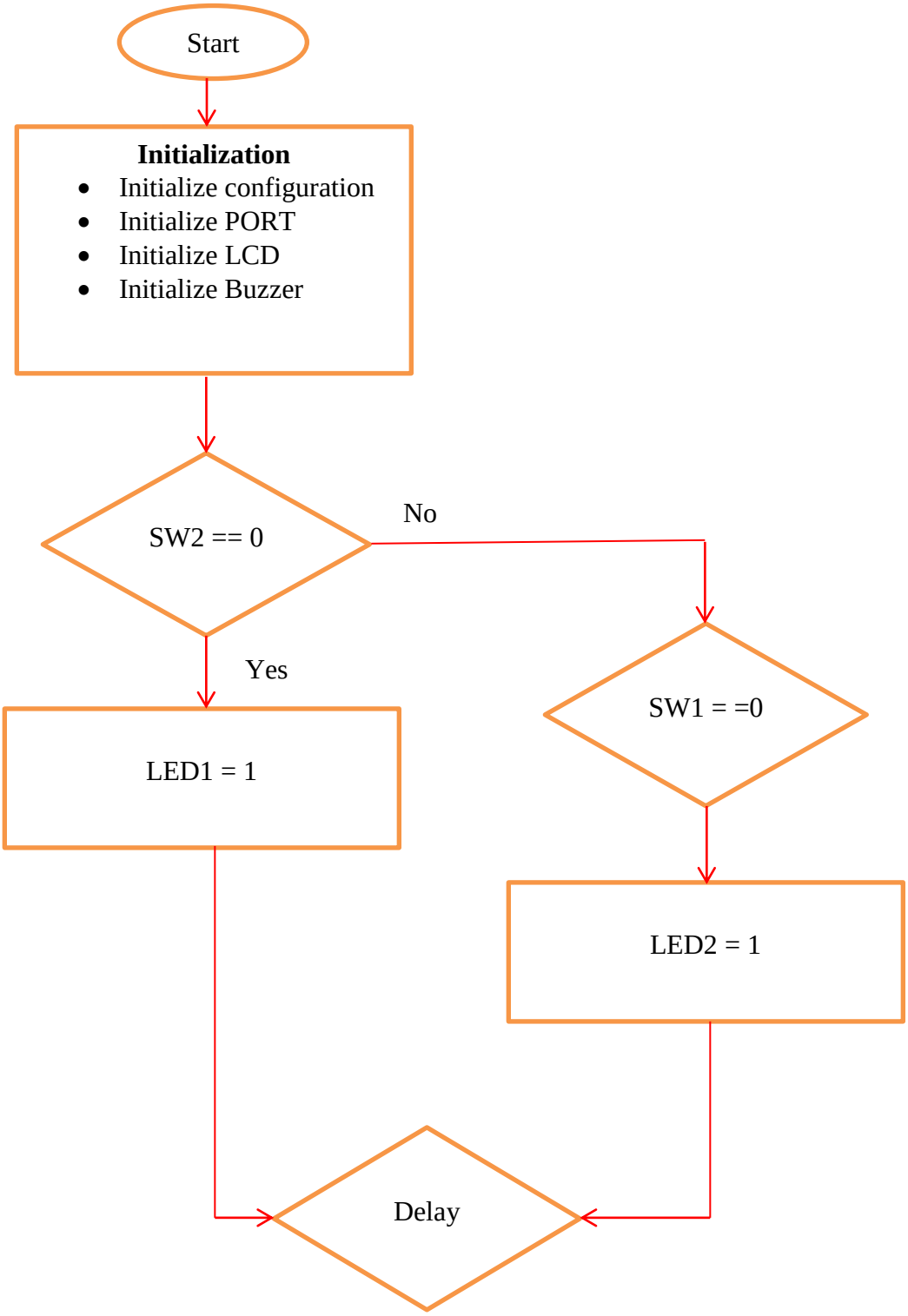


Figure 3.4 Flow Chart of PIC16F877A Main Program

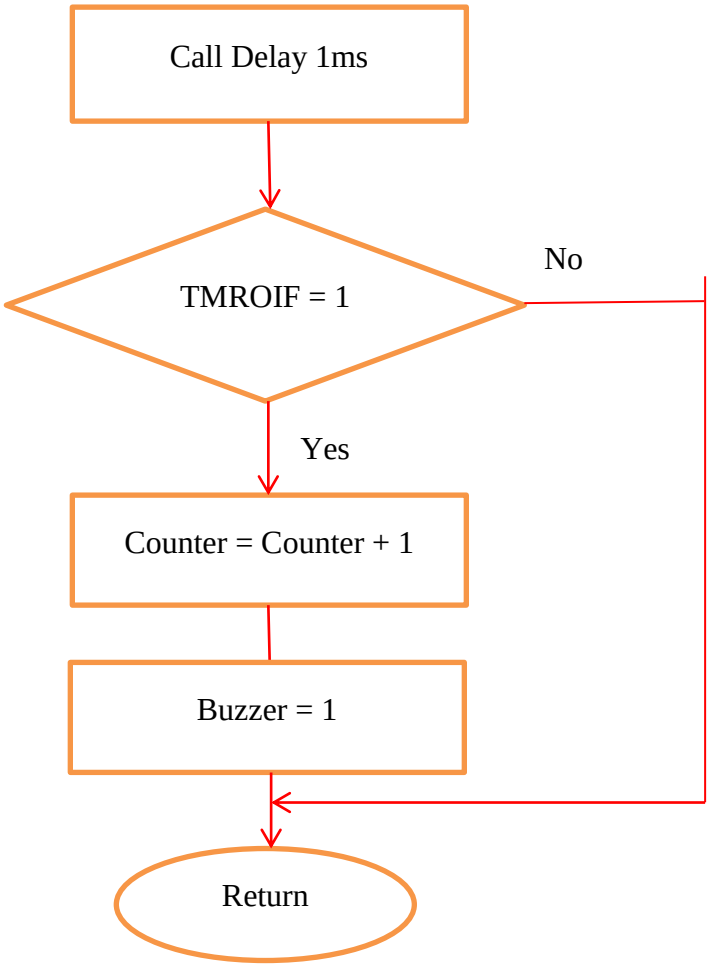


Figure 3.5 Flow Chart of Interrupt Function

There are three main parts of main program in microcontroller. The initialization of configuration, ports, LCD and buzzer, push switch button, LED light indicator. There also three parts in the interrupt process which are Timer0, counter and buzzer.

3.2.1.1 Initialization of configuration for PIC16F877A

Before starting to write the program, the PIC16F877A need to configure first. The configuration of the PIC 16F877A is given in source code of the program in appendix.

3.2.1.2 Initialization of Ports

In this project, we used Port B, RB0, RB1 and RB2 as an input ports and Port D, RD0 until RD7 as an output. When the input Port B high (=1), it will send an output to Port D to display the output.

3.2.1.3 Initialization of LCD

All pins of LCD need to be connected to the SK40C startup kit and the initialization of the ports given in the appendix. The initialization of ports for LCD is set as Port D as an output.

3.2.1.4 Initialization of Buzzer

Buzzer that act as an alarm system need to be initialize so that the program work accordingly. The initialization of the buzzer is the RB2 will be defining as buzzer and the connection is at table 3.1.

3.2.1.5 Push Switch Button

According to the flow chart at figure 3.4, if the SW2=0, LED1 will light up and vice versa. The process will continue until one of the player run out of time.

3.2.1.6 Interrupt Explanation

Firstly, the Timer0 needs to enable first so that the counter will increment. The counter will increment until the time limit for the player finish. Buzzer will sound as the time finish.

3.2.2 MPLAB IDE and PICkit 2 Software Setup

3.2.2.1 MPLAB IDE Software Setup

When install MPLAB Integrated Development Environment (IDE), we need to ensure that HI-TECH PICC-Lite also install. This HI-TECH PICC-Lite is the third compiler for PIC16 families. Open the MPLAB IDE to start a new project start to write the coding. After that, build the source code to check the error. If there are no error, a message will 'Build successful' will appear in output window. After compile the source code, the software will automatically generate the hex file that will be used by PICkit 2 software. The setup of the software will be shown below.

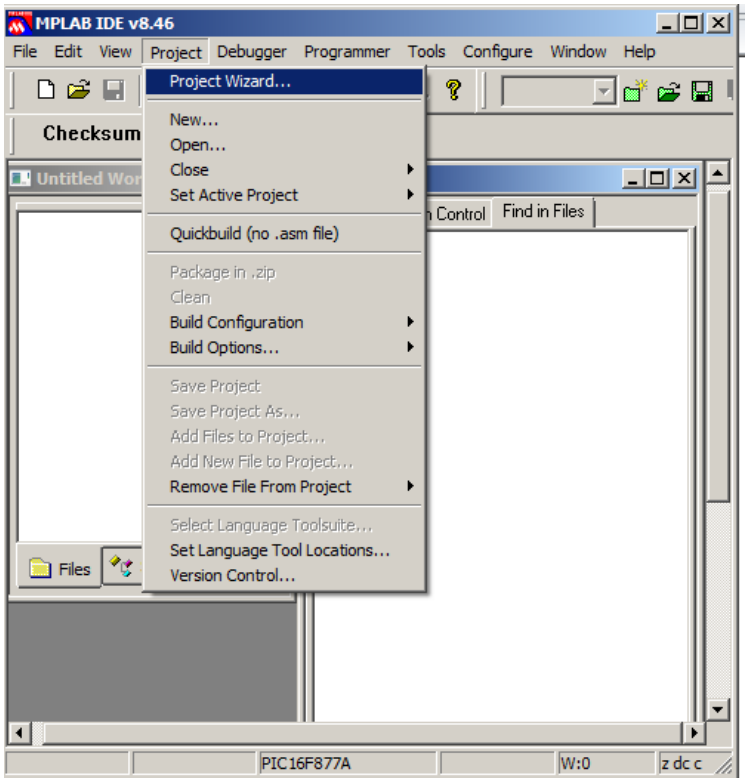


Figure 3.6 MPLAB IDE Programming Setup

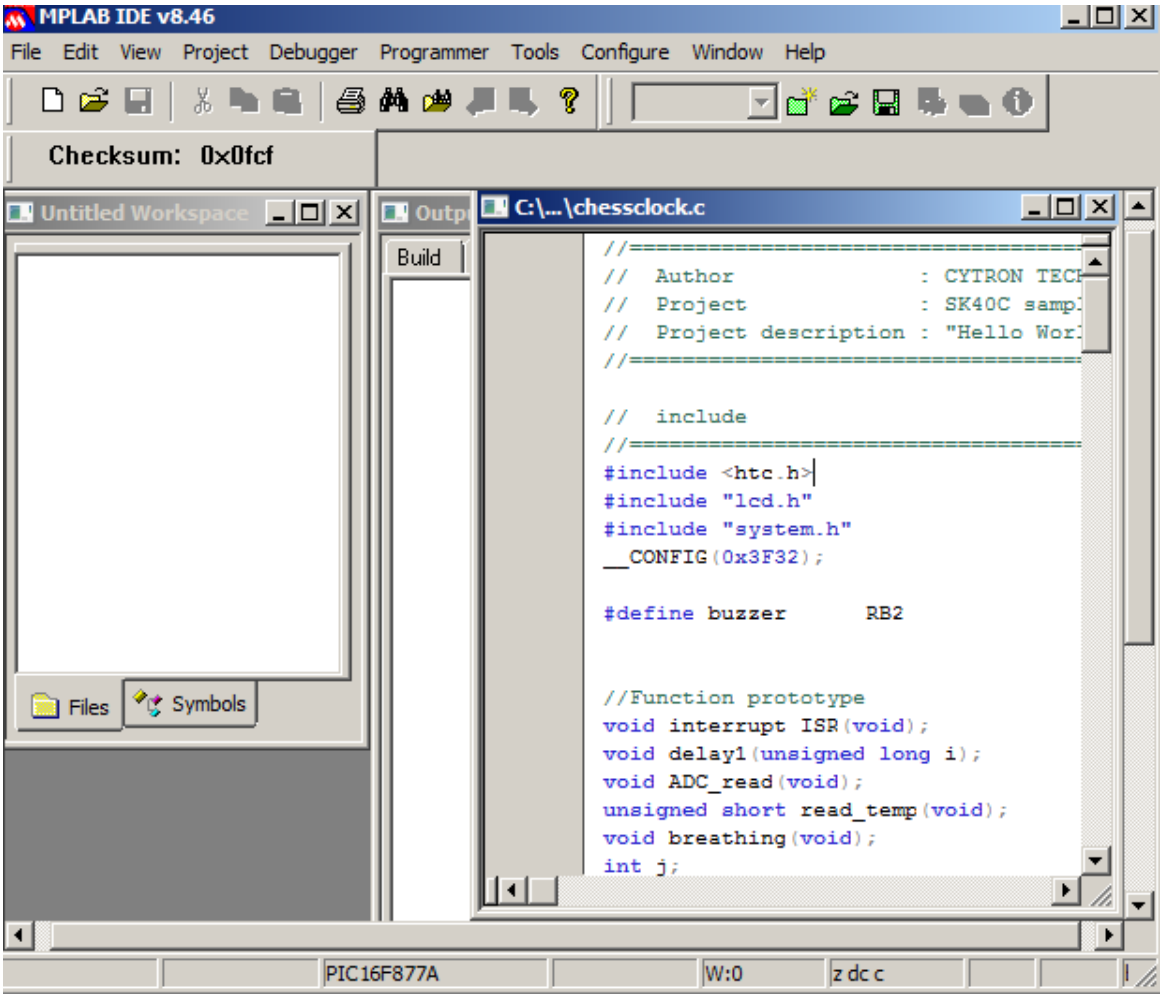


Figure 3.7 Source Code of the Project

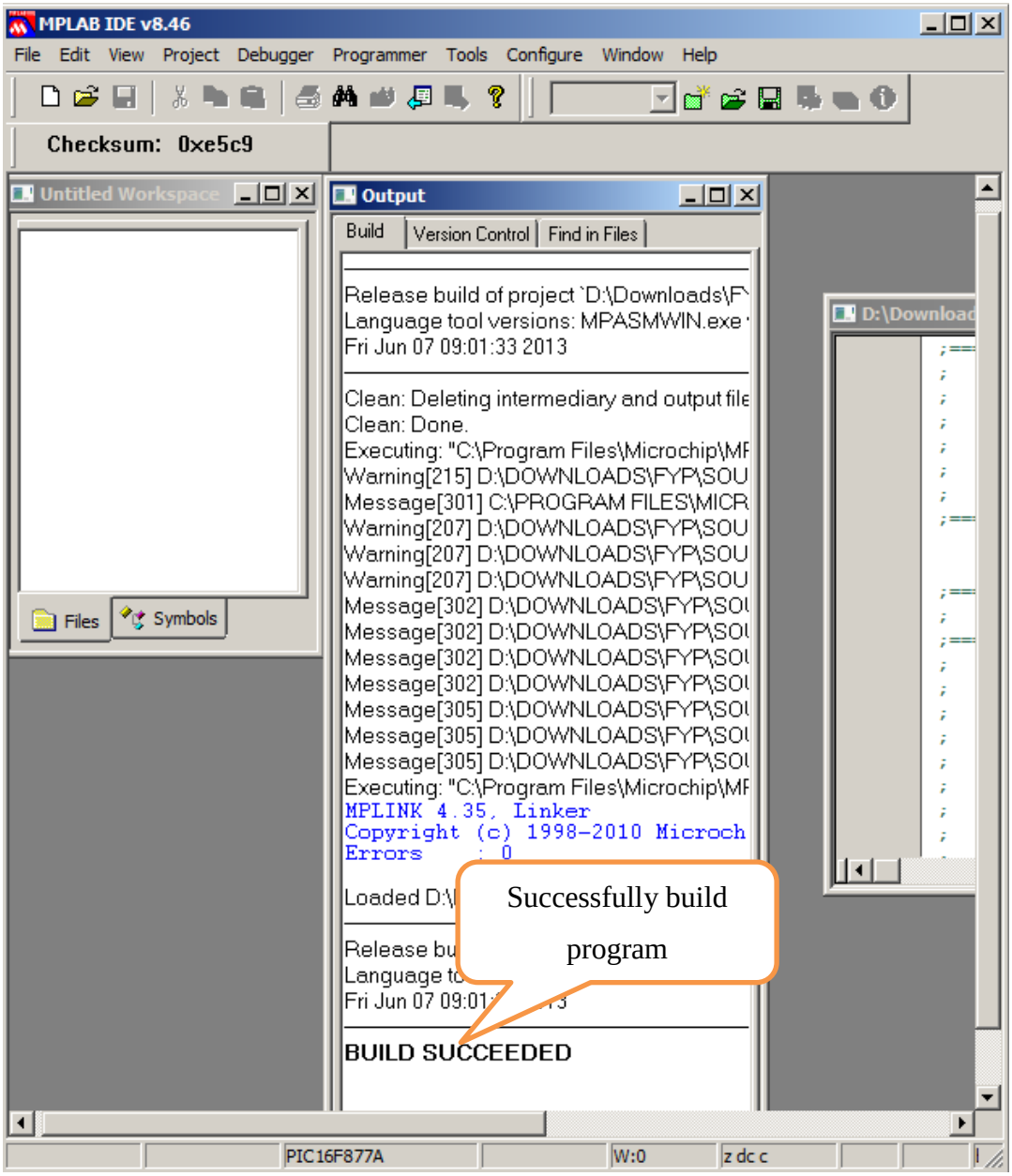


Figure 3.8 Successful Build Program at MPLAB IDE

3.2.2.2 PICkit 2 Software Setup

This software is use only to import the hex file onto the PIC microcontroller. Connect the UIC00B PIC programmer to computer and check the connection of the PIC programmer by clicking tool menu.

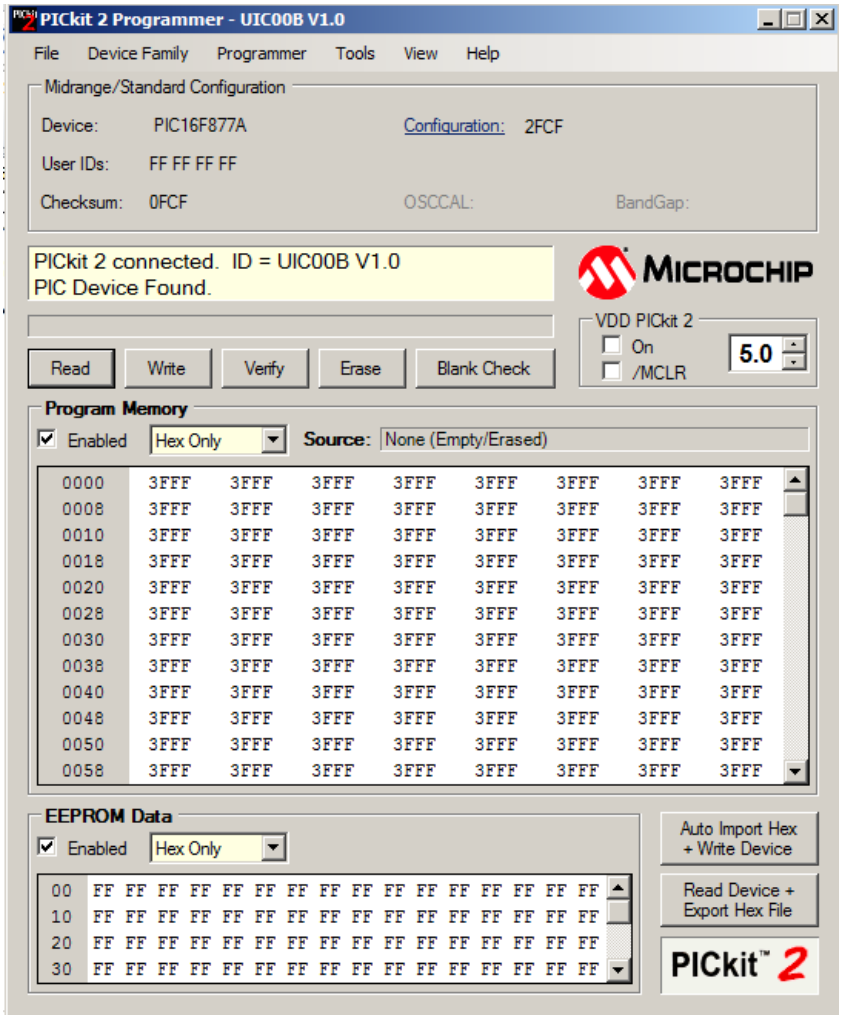

PICkit 2 Programmer - UIC00B V1.0
File
Device Family
Programmer
Tools
View
Help
Midrange/Standard Configuration
Device: PIC16F877A
Configuration: 2FCF
User IDs: FF FF FF FF
Checksum: 0FCF
OSCCAL:
BandGap:
PICkit 2 connected. ID = UIC00B V1.0
PIC Device Found.
MICROCHIP
VDD PICkit 2
On
/MCLR
5.0
Read
Write
Verify
Erase
Blank Check
Program Memory
Enabled
Hex Only
Source: None (Empty/Erased)
0000 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0008 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0010 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0018 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0020 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0028 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0030 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0038 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0040 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0048 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0050 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0058 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
EEPROM Data
Enabled
Hex Only
00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
10 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
20 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
30 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
Auto Import Hex + Write Device
Read Device + Export Hex File
PICkit 2

Figure 3.9 Successful Connection of IUCOOB PIC Programmer

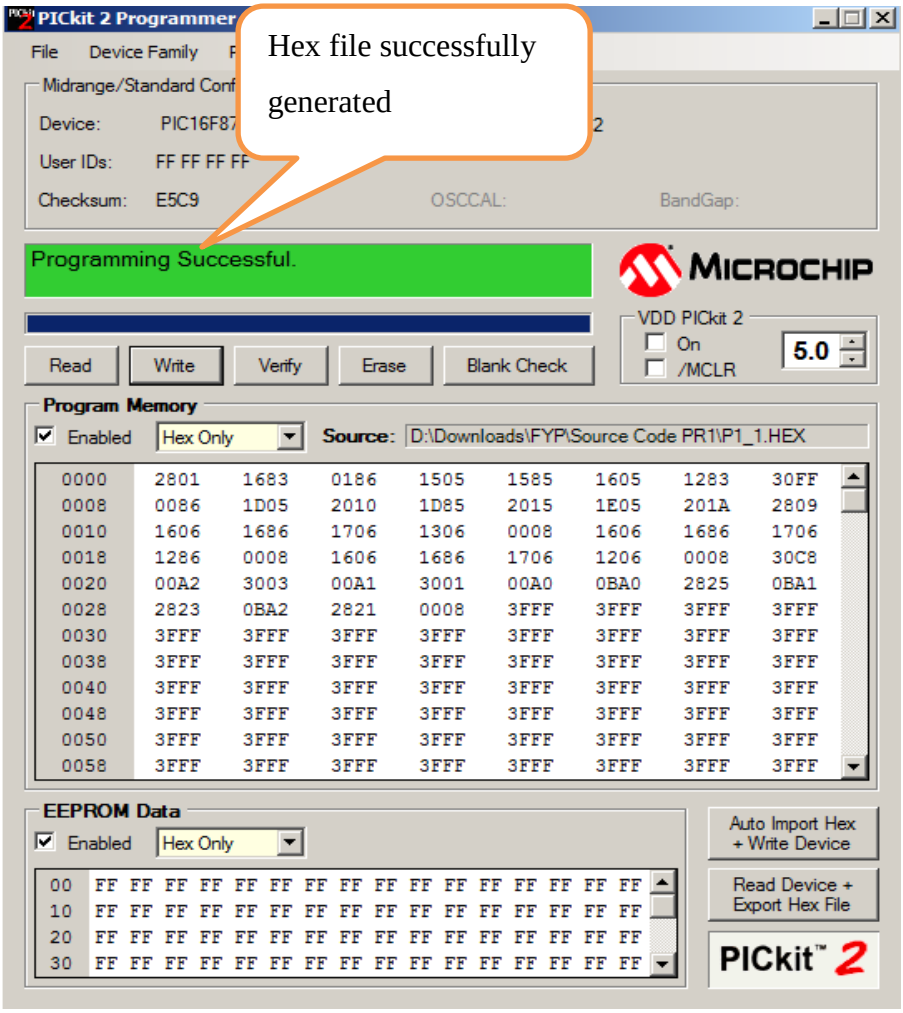

PICkit 2 Programmer
File
Device Family
Hex file successfully generated
Midrange/Standard Conf
Device:
PIC16F87
User IDs:
FF FF FF FF
Checksum:
E5C9
OSCCAL:
BandGap:
Programming Successful.
MICROCHIP
VDD PICkit 2
On
/MCLR
5.0
Read
Write
Verify
Erase
Blank Check
Program Memory
Enabled
Hex Only
Source:
D:\Downloads\FYP\Source Code PR1\P1_1.HEX
0000 2801 1683 0186 1505 1585 1605 1283 30FF
0008 0086 1D05 2010 1D85 2015 1E05 201A 2809
0010 1606 1686 1706 1306 0008 1606 1686 1706
0018 1286 0008 1606 1686 1706 1206 0008 30C8
0020 00A2 3003 00A1 3001 00A0 0BA0 2825 0BA1
0028 2823 0BA2 2821 0008 3FFF 3FFF 3FFF 3FFF
0030 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0038 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0040 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0048 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0050 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
0058 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF 3FFF
EEPROM Data
Enabled
Hex Only
00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
10 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
20 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
30 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
Auto Import Hex + Write Device
Read Device + Export Hex File
PICkit 2

Figure 3.10 Successfully Generate Hex File into PIC 16F877A

CHAPTER 4

RESULT AND DISCUSSION

4.1 Result and Discussion

The result will show the time digital of chess clock. For the demonstration of the project, the time limit for each player is only for 10 seconds. Each player both will have 10 seconds to move the chess and the player who do not move in the time limit will be consider lose in the game.

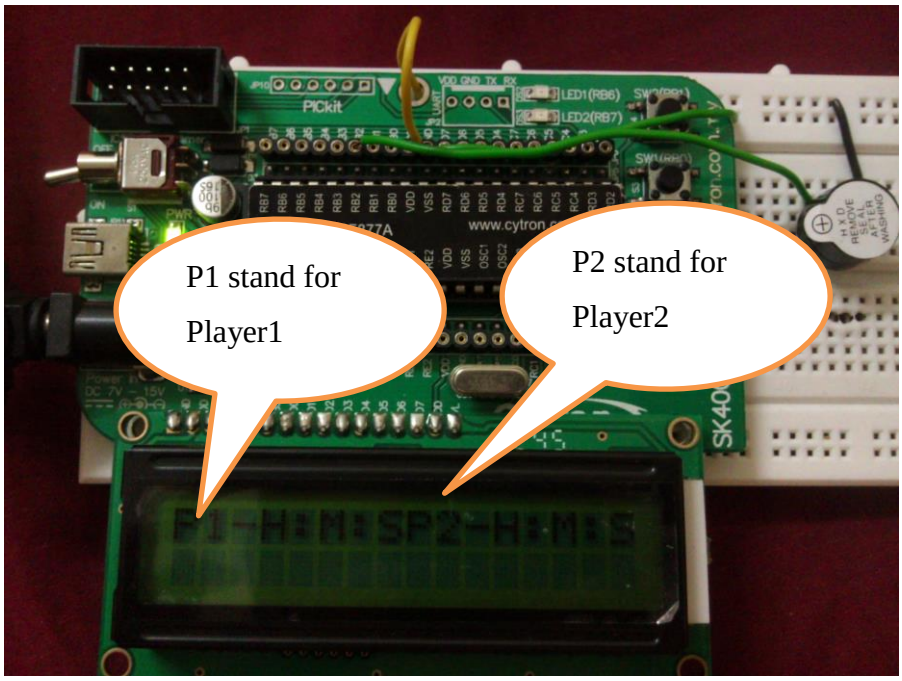


Figure 4.1 Two Player Start the Chess Game

Figure 4.1 shows the two players who will start the game. Both players are set to have hour, minutes and seconds in their time. At the LCD display above, P1 stand for player 1 and P2 stand for player 2.

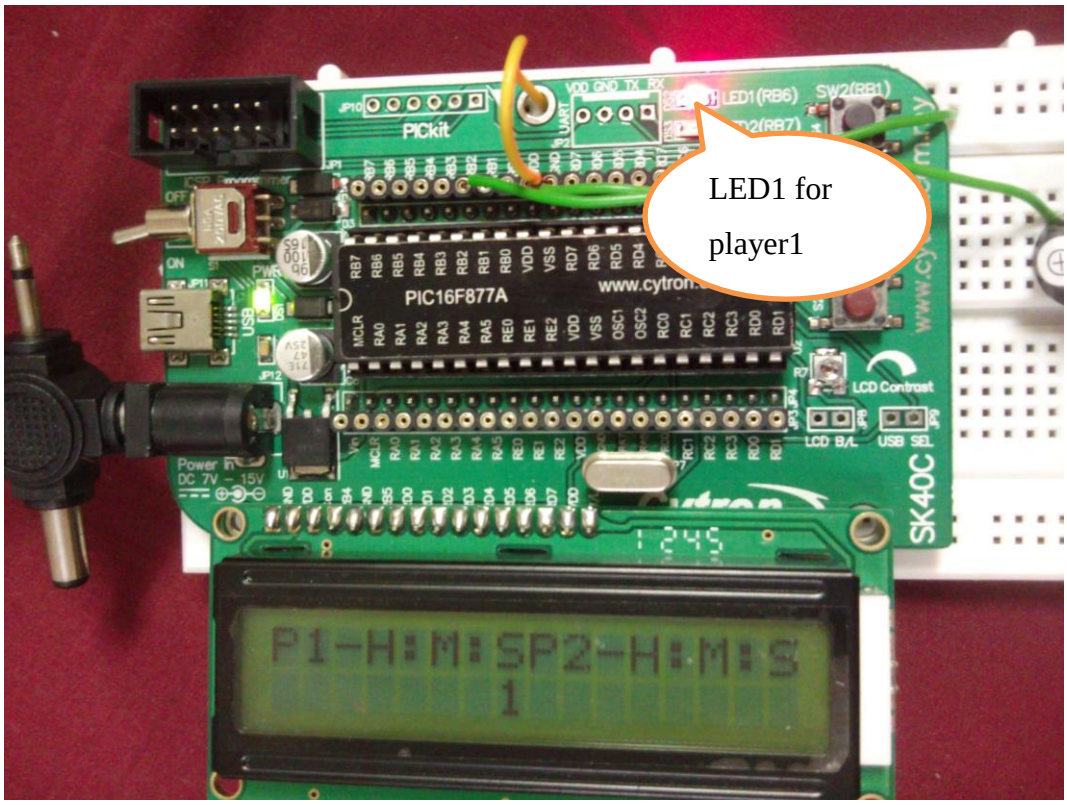


Figure 4.2 Time Taken for Player1 to Move the Chess

Figure 4.2 above shows that the time taken for the player 1 to make one move for the game. Red LED1 will light up to show that it is the player 1 turn to move. After player 1 is done with move, player 2 has to start move because the time already set to counter. Before this, the digital chess clock uses only show the time but in this digital chess clock, there will be two LED light for two players and a buzzer to alarm the player. This LED will be used as an indicator to show which player move at a time and the people around them will know which player's turn without asking anywhere. This LED light is also important in the tournament since this game will need high concentration and the viewer can look at the game and know the player's turn without asking. In case of the player do not move the chess in the time limit, the buzzer will sound and the game is over. Figure 4.3 will show the time taken for the player 2 to move and the yellow LED2 will light up.

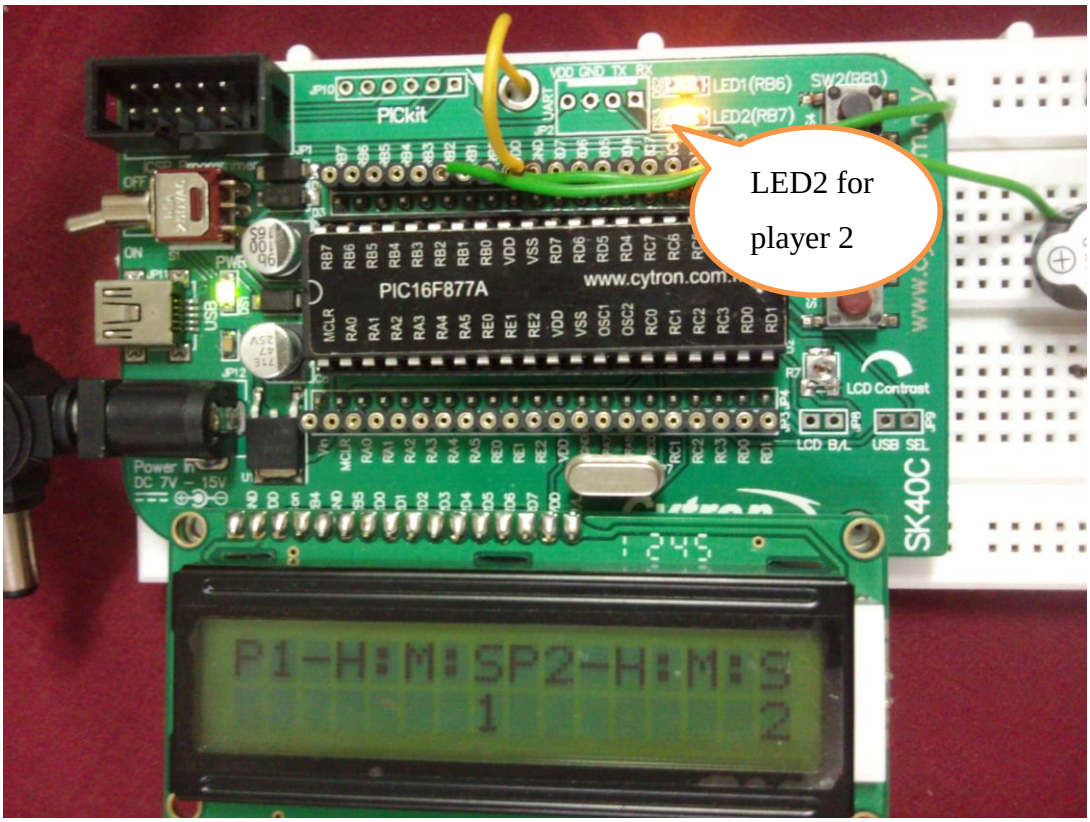


Figure 4.3 Time Taken for Player2 to Move the Chess

Figure 4.3 show that the time taken for the player to move a chess. As we can see from the figure 4.3, the time taken for the player 2 to complete the move is 2 seconds. Since he can complete the move before time limit, he is saves in this round and player 1 will continue with his move. As the player 2 move the chess clock, LED2 will light up to show that it is player 2 turn.

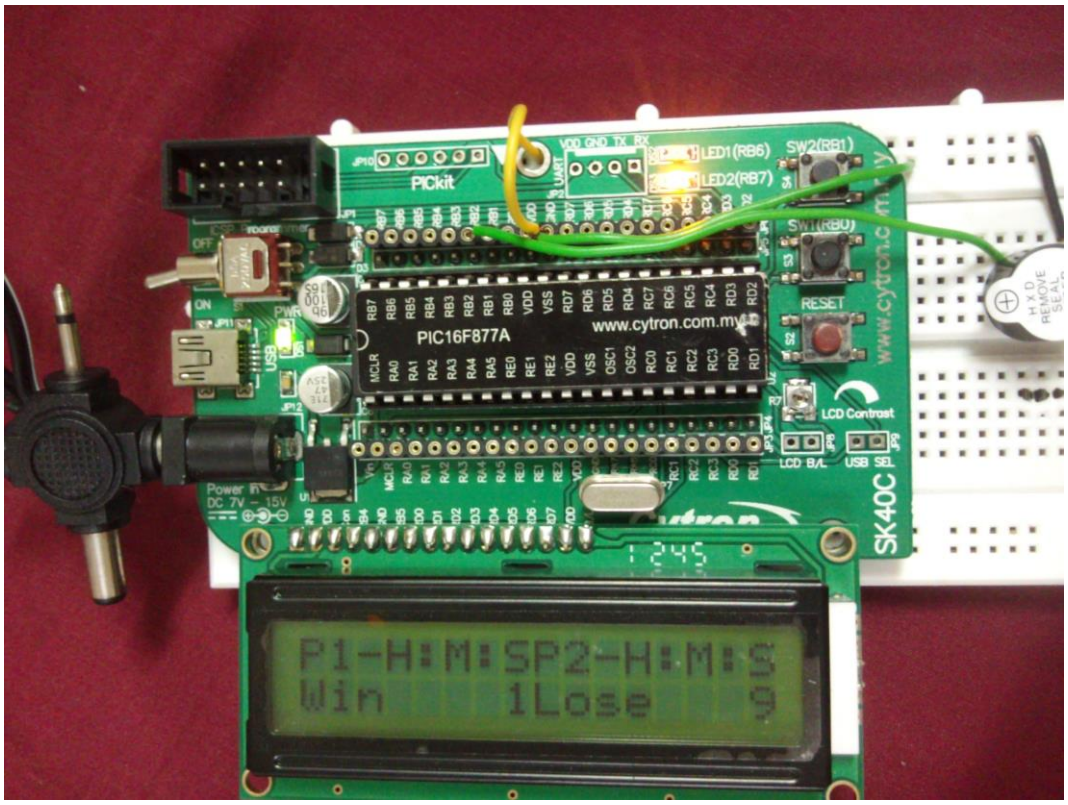


Figure 4.4 LCD Display for Which Player Win and Lose

The figure 4.4 above shows that the player 2 that lose in the game. The reason for the player 2 to lose is because the time taken for the player 2 is already 10 seconds. Since this demonstration only take 10 seconds for each player, the player who do not move in the time limit will lose in the game. Along with the LCD display to show which player who lose in the game, the buzzer will sound so that the player will know that he lost in the game.

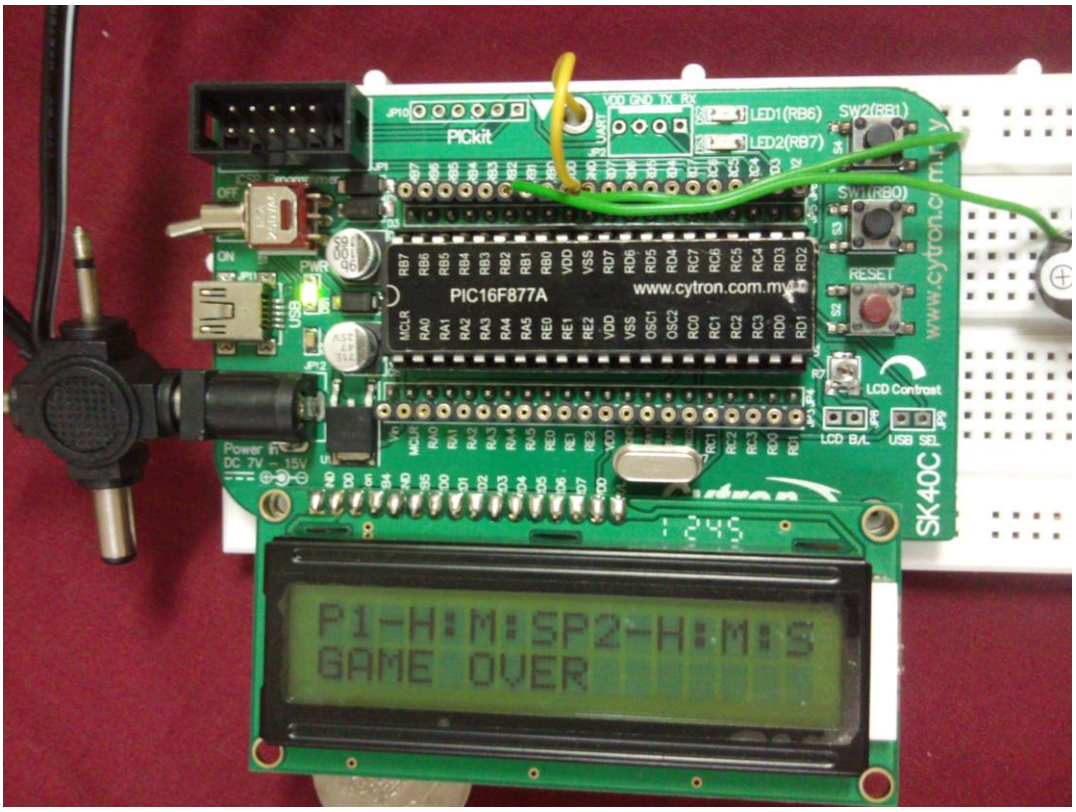


Figure 4.5 Game Over for Both Player

Figure 4.5 shows the game over for both of the players if there were no move in the 30 seconds time. This digital chess clock already being set if there were no move in 30 seconds time, both players will lose the game. This time limit of the 30 seconds is to ensure that the game will follow the standard time so that no lagging time in the game. It also to ensure both players will start play as soon as possible because the time already starts after the ON button was pressed.

This digital chess clock is set to have 10 seconds for each player but the time limit for both players can be change higher in the source code. This time limit is only for the demonstration only. Since the button SW1 and SW2 for both players is not like the other switch, so if the player 1 wishes to start the game, he must press the button SW1 along with move the chess game because the time will stop if he stops to press.

The switch will detect the time only if the switch was being pressed. This type of switch need to be replace so that the players will not have to press the switch all the time.

The buzzer that used in this digital chess clock was only used for the alarm for the player. Since the sound may or may not distract other players in the tournament, the buzzer can be change to other type or the time for the buzzer to sound will be limit so that the sound does not distract other players. The control of the switch, LED, LCD display and buzzer are all in the source code. So, to change the setting of the program, we just have to modify a little bit of the program.

CHAPTER 5

CONCLUSION

5.1 Conclusion

The digital chess clock is an important and easier clock to be used in the chess tournament. This digital chess clock will give finite time for the players in the tournament. Since this digital chess clock using additional functionality such as LED light and buzzer, the digital chess clock will be much effective other than existing digital chess clock.

As a conclusion, this digital chess clock using PIC 16F877A was unsuccessfully. The first objective was successfully because the designation and implementation of the chess clock onto the board SK40C start-up kit was successful. The interfacings of LCD display to microcontroller and applying the PIC microcontroller and implement it onto hardware installation also successful but the total design of the digital chess clock is not successful since the time limit is not accurate. To show the successful hardware design,

the time is being shown at LCD display. The digital chess clock that has other function except for time is successfully developed.

This digital chess clock has other function such as LED light as an indicator and buzzer that acts an alarm system. This buzzer will sound if the player runs out of time. Apart from that, the digital chess clock was being designed as a low cost hardware. Since the price of the other existing digital chess clock with microcontroller is expensive and most tournament still used old clock, so the implementation of the digital chess clock meet the criteria of affordable device.

5.2 Problem

The problem arise in the project are the connection of the project is not accurate. This can cause the reading of the time in LCD display is not accurate. Since the design of the digital chess clock is incomplete, the time limit of the chess clock is not accurate. The timing of the digital chess clock is not multitasking since it can only read until 10 seconds only.

5.3 Recommendation

In order to commercialize the device to the pubic used, some improvements needs to be done. So, for the future work, some other function of the digital chess clock needs to be added so the clock becomes much more interesting.

Other than that, the switch button needs to be replaced so that the player does not have to press the switch all the time. The alarm system also needs to change because the sound is too loud. For the LED light, the LED light will make it blink so that the device becomes more interesting.

REFERENCES

1. Tony Foley. Chess Magic. Irish Chess Journal. August 2011. Pg. 03.

2. Nasrul Humaimi. And Che Ku Mohd Solahuddin. Smart Electronic Chess Board Using Reed Switch. Jurnal Teknologi. Vol. 55. 2011. Pg. 41-52
   1.
3. M. Zhafri M. Yaacob. Speed Chess Clock. Universiti Teknikal Malaysia Melaka. April 2010

4. Albert A. Monichino. Chess Clock Hearing Procedure. Asian Dispute Review. Hong Kong International Arbitration Centre. July 2009.

5. Rosmira Roslan. Digital Chess Clock. Universiti Malaysia Pahang. 2008

6. Mark E. Appel. Management Technique for Complex Cases.. Dispute Resolution Journal. May 2006. pg. 83-86

7. Elo, A. The ratings of chess players, past and present. New York: Arco. 1978.

8. De Groot, A. Thought and choice in chess. The Hague Mouton. 1965

9. Wissen 1st Matt. Chess Base 12. 2012

10. Marie Brannon. History of Timers and Clocks in Chess Matches. 2009.

11. Cytron Tech. SK40C User Manual. March 2011.

12. Microchip. PIC 16F877A Microcontroller Data Sheet. 2003

13. MPLAB IDE. Simulator. Editor's User Guide.

APPENDIX

Program in PIC16F877A for Digital Chess Clock

```
//=============================================================
//Author        : NURLIA SYAKILA BINTI CHE HUSIN
//Project       : DIGITAL CHESS CLOCK USING PIC 16F877A
                  MICROCONTROLLER
//=============================================================
//        include
//=============================================================
#include <htc.h>
#include "lcd.h"
#include "system.h"
__CONFIG(0x3F32);

#define buzzer          RB2


//Function prototype
void interrupt ISR(void);
void delay1(unsigned long i);
void ADC_read(void);
```

```
unsigned short read_temp(void);
void clock(void);
int j;
int k;
unsigned short counter=0;

//Main Function
unsigned short result;
unsigned short temp;

void main(void)
{
        ADRESH=0;
        ADRESL=0;

        ADCON1=0b11000010;

        TRISA=0b00000010;                       // set AN1 as input port
        TRISB=0b00001011;                       // set PORTB RB0-RB2 as input
        TRISD=0b00000000;                       // set PORTD as OUTPUT

        GIE = 1;              //Enable Global Interrupt
        INTE = 0;              //Enable RB0/INT external Interrupt
        PEIE = 0;              //Disable all unmasked peripheral interrupt
        TMR0IE=1;
        T0CS=0;
        T0SE=0;
        PSA=0;
        PS2=1;
        PS1=1;
        PS0=1;          //set prescale 1:4
```

```
PORTA = 0;                                          // clear PORT
PORTB = 0;
PORTD = 0;

lcd_initialize();
lcd_clear();
lcd_goto(0x00);
lcd_putstr("P1-H:M:S");
lcd_goto(0x08);
lcd_putstr("P2-H:M:S");

while(1)
{
        if(SW2==0) //player1
        {

                LED1=1;
                LED2=0;
                j=j++;
                lcd_goto(0x47);
                lcd_bcd(1,j);
                delay1(135135);
                if(j==9)
                {
                        lcd_goto(0x40);
                        lcd_putstr("Lose");
                        lcd_goto(0x48);
                        lcd_putstr("Win");
                        j=j;
                }
```

```
                }
                else if(SW1==0)  //player2
                {

                        LED2=1;
                        LED1=0;
                        k=k++;
                        lcd_goto(0x4F);
                        lcd_bcd(1,k);
                        delay1(135135);
                        if(k==9)
                        {
                                lcd_goto(0x40);
                                lcd_putstr("Win");
                                lcd_goto(0x48);
                                lcd_putstr("Lose");
                                k=k;
                        }
                }

        }
        delay(10000);
}



//subroutine DELAY
void delay1(unsigned long i)
{
  for(;i>0;i--);
}
```

```
//subroutine INTERRUPT TIMER0
void interrupt ISR(void)
{
        TMR0IF=1;
        counter++;
        if(counter==4578)
        {
                buzzer=1;
                lcd_goto(0x40);
                lcd_putstr("GAME OVER");

        }

        TMR0IF=0;       // clear the interrupt flag
}
```